REMARKS

Claims 5 and 9 are pending in this application. In view of the following remarks reconsideration and withdrawal of the rejections are respectfully requested.

I. Rejections Under 35 U.S.C. §103

A. Engeler in View of Seki

The Office Action rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,558,375 to Engeler ("Engeler") in view of U.S. Patent No. 5,409,569 to Seki et al. ("Seki"). Applicant respectfully traverses the rejection.

Independent claim 5 recites, "A method for evaluating crystal defects of a silicon wafer comprising: etching a surface of the silicon wafer by immersing the wafer in an etching solution; and observing etch pits formed on the etched surface of the wafer, wherein the silicon wafer of which crystal defects are evaluated has low electrical resistivity of 1 Ω•cm or less, and the etching solution is a mixture of hydrofluoric acid, nitric acid, acetic acid and water further including iodine or iodide, the etching solution satisfies at least one of (i) a volume ratio of hydrofluoric acid : nitric acid : acetic acid : water is 1 : 13-17 : 4-8 : 4-8 and/or (ii) includes iodine or iodide in a range from 0.01 g to 0.09 g per 1 liter of total liquid volume of the etching solution, and the etching solution is adjusted to have an etching rate of 100 nm/min or less for the silicon wafer." (Emphasis added). Such a method would not have been obvious over the cited references.

Conventionally, it is extremely difficult to accurately evaluate crystal defects of a silicon wafer with a low electrical resistivity of 1 Ω•cm or less. See specification, page 3, line 8 - page 4, line 17. To address this problem, the claimed method applies the following: adds iodine or iodide to an etching solution to prevent formation of an unsaturated oxide film or a stain film; increases a ratio of nitric acid, which is an oxidizing agent, to increase an oxidizing rate at defect sites to enhance selectivity of etching; and decreases an etching rate of

the etching solution. See specification, page 9, line 25 - page 10, line 10. Thus, the claimed method "prevents forming an unsaturated oxide film or stains (a stain film) on the surface of the silicon wafer in etching. In addition, selectivity of etching is high. Therefore, crystal defects of a silicon wafer with low electrical resistivity are detected with excellent capability of detecting the defects, and the defects are evaluated accurately." Specification, page 6, lines 2-9. Through the claimed method, it becomes possible to accurately evaluate crystal defects of a silicon wafer with a low electrical resistivity of 1 Ω•cm or less by using the claimed etching solution having an etching rate of 100 nm/min or less and evaluating crystal defects of a silicon wafer by observing etch pits formed on the etch surface of the wafer with low electrical resistivity. Engeler and Seki, individually or in combination, fail to teach or suggest at least the above features of claim 5.

Engeler discloses a method of fabricating diodes comprising an etching step. Engeler further discloses that a silicon nitride layer is removed with an etchant comprising, "160 cc. acetic acid, 0.5 gm. iodine, 280 cc. nitric acid and 50 cc. 48% HF." Engeler, col. 7, lines 24-25. Therefore, Engeler discloses a volume ratio of hydrofluoric acid : nitric acid : acetic acid : water of 1 : 5.6 : 3.2 : 0, which differs from the volume ratio of 1 : 13-17 : 4-8 : 4-8 of hydrofluoric acid : nitric acid : acetic acid : water, as recited in claim 5. Additionally, Engeler discloses an etching solution that includes iodine or iodide at a ratio of 1 g per 1 liter of total liquid volume of the etching solution, which significantly differs from the ratio of 0.01 g to 0.09 g per 1 liter as recited in claim 5. Also, Engeler does not disclose the claimed etching rate of 100 nm/min or less.

Further, Engeler is directed to fabrication of diodes comprising an etching step, and thus, Engeler does not disclose a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. Therefore, Engeler does not teach or suggest that an etching solution can or should be modified in order to evaluate crystal defects of a silicon wafer by

observing etch pits formed on the etched surface of the wafer with low electrical resistivity. For at least this reason, Engeler does not provide any reason or rationale for one of ordinary skill in the art to have modified the etching solution of Engeler to achieve the claimed etching solution. Thus, Engeler fails to teach or suggest the combination of features recited in claim 5 that allows one of ordinary skill in the art to evaluate crystal defects on a silicon wafer with low electrical resistivity.

Additionally, Seki merely discloses an etchant containing hydrofluoric acid and an oxoacid or oxoacid salt compound expressed by Mm(XOn)p. See Seki, col. 2, lines 66-68. Seki discloses that the above etching solution can be used to address degeneration of a photoresist, deterioration in adhesion between a photoresist and a silicon to be treated that exists when a conventional etchant is used, and prohibits the formation of fine patterns. See Seki, col. 2, lines 18-33. Seki also discloses that acetic acid acts to damage the photoresist such that dissolved portions of the photoresist are produced. Seki discloses that the use of acetic acid changes the photoresist into a porous film, and that this deterioration has impeded the conventional etchant from being applied to form fine patterns on a photoresist. See Seki, col. 2, lines 34-41.

However, the etching solution as recited in claim 5 includes acetic acid. When the volume ratio of acetic acid and water in the etching solution is increased, the etching rate of the etching solution is decreased considerably. See specification, page 18, lines 18-24. In other words, in order to decrease an etching rate to the claimed range of 100 nm/min or less, acetic acid is an important component of the etching solution. In contrast, as mentioned above, Seki discloses that acetic acid deteriorates the photoresist. Thus, Seki discloses that an important component of the claimed etching solution should in fact not be included in an etching solution.

Further, the Office Action asserts that Seki discloses, at col. 2, lines 42-50, an iodine etchant in which iodine is added to the conventional mixed solution of hydrofluoric acid, nitric acid and acetic acid. However, Seki discloses that the iodine is added in an attempt to increase an etching rate. See Seki, col. 2, lines 44-46. However, according to the claimed invention, the solution as recited in claim 5 is used to decrease the etch rate of the etching solution. Therefore, at least because Seki discloses that an iodine, hydrofluoric acid, nitric acid and acetic acid solution is used to increase the etch rate of an etching solution, Seki does not provide any reason or rationale for one of ordinary skill in the art to have utilized the claimed etching solution with the amount of iodine as recited in claim 5 in order to decrease an etching rate of an etching solution.

Furthermore, Seki discloses an etchant and a method for etching a silicon semiconductor material using the etchant. But, unlike claim 5, Seki does not disclose a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. Thus, Seki does not provide any reason or rationale for one of ordinary skill in the art to have modified the etching solution disclosed by Seki to the claimed etching solution, at least because the claimed etching solution is formulated to optimize evaluation of crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity. Therefore, Seki fails to teach or suggest that the claimed etching solution should be used so that one of ordinary skill in the art can evaluate crystal defects of the silicon wafer with low electrical resistivity.

Additionally, neither Engeler nor Seki provide any reason or rationale for one of ordinary skill in the art to have combined the references as suggested by the Office Action. Engeler is directed to a method of fabricating diodes and Seki is directed to a method for etching a silicon semiconductor material using an etching solution. It would not have been obvious to one of ordinary skill in the art to have combined these differing methods as

suggested in the Office Action. Also, as discussed above, Seki discloses that acetic acid should not be used in the etching solution disclosed therein because it deteriorates the photoresist; however, Engeler discloses that acetic acid should be used in the etching solution disclosed in Engeler. Thus, it would not have been obvious to one of ordinary skill in the art to combine an etching solution with acetic acid, as disclosed in Engeler, with an etching solution that does not include acetic acid, as disclosed in Seki.

Further, even if one of ordinary skill in the art were to have combined Engeler and Seki, the combination would not have resulted in an etching solution with the volume ratio of hydrofluoric acid : nitric acid : acetic acid : water of 1 : 13-17 : 4-8 : 4-8 and/or including iodine or iodide in a range from 0.01 g to 0.09 g per 1 liter of total liquid volume of the etching solution. The claimed etching solution would not have been achieved at least because neither Engeler nor Seki disclose the claimed etching solution, and neither reference, individually or in combination, teach or suggest that the components of the etching solutions disclosed therein can or should be modified to be within the claimed ranges at least because the references do not disclose a method for evaluating the crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity. Therefore, even if Engeler and Seki were to be combined, the combination would not have yielded the method of claim 5.

For at least the reasons stated above, claim 5 would not have been rendered obvious by Engeler and Seki, individually or in combination. Claim 9 depends from claim 5 and, thus, also would not have been rendered obvious by Engeler in view of Seki, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

B. Tiemann in View of Seki

The Office Action rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,772,102 to Tiemann et al. ("Tiemann") in view of Seki. Applicant respectfully traverses the rejection.

Tiemann merely discloses methods for producing a desired pattern of retained and removed portions in a substrate layer of a material selected from the group consisting of silicon nitride, an oxide of silicon, and an oxynitride silicon. See Tiemann, Abstract. Additionally, Tiemann discloses an etching solution including two parts concentrated HF acid, five parts nitric acid, three parts glacial acetic acid and about 0.7 grams per liter of iodine that can be used on silicon. See Tiemann, col. 4, lines 1-5. However, Tiemann does not disclose the claimed volume ratio of hydrofluoric acid : nitric acid : acetic acid : water of 1 : 13-17 : 4-8 : 4-8. Also, Tiemann fails to disclose the claimed ratio of iodine or the claimed etching rate of 100 nm/min or less. Further, Tiemann is directed to a method for producing a desired pattern of retained and removed portions in a substrate layer, and, unlike claim 5, Tiemann is not directed to a method for evaluating crystal defects of a silicon wafer with low electrical resistivity. Therefore, for reasons similar to the arguments made above in regards to the discrepancies of the Engeler reference, Tiemann does not disclose the claimed etching solution, or provide any reason or rationale for one of ordinary skill in the art to have modified the etching solution disclosed therein to be within the claimed ranges at least because Tiemann does not disclose a method of evaluating crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity. Thus, the Office Action combines the disclosure of Seki with the disclosure of Tiemann to address the discrepancies of Tiemann as to claim 5.

The disclosure of Seki is discussed above, and for similar reasons as argued above, Seki fails to address the discrepancies of Tiemann as to claim 5. Particularly, as discussed

above, Seki discloses that acetic acid acts to damage the photoresist and thus, Seki discloses that acetic acid should not be used in the etching solution. Additionally, Seki discloses that an iodine solution should be used to increase an etch rate, rather than to decrease the etch rate, as is recited in claim 5. Also, Seki fails to disclose a method for evaluating crystal defects of a silicon wafer by observing etch pits on the etched surface of the wafer with low electrical resistivity and thus, as discussed above, Seki does not provide any reason or rationale for one of ordinary skill in the art to have modified the etching solution disclosed in Seki to be within the ranges recited in claim 5.

Further, Tiemann is directed to a method for producing a desired pattern of retained and removed portions in a substrate layer, while Seki is directed to a method for etching a silicon semiconductor material using an etching solution. However, neither Tiemann nor Seki provide any reason or rationale for one of ordinary skill in the art to have combined these differing methods as suggested by the Office Action. Particularly, as discussed above, Seki discloses that acetic acid should not be used in the etching solution disclosed therein, and Tiemann discloses that acetic acid should be used in the etching solution disclosed therein. Therefore, it would not have been obvious to one of ordinary skill in the art to have combined the etching solutions disclosed in the Tiemann and Seki references.

Furthermore, even if Tiemann and Seki were to be combined, the combination would not have yielded the method of claim 5. Specifically, neither Tiemann nor Seki disclose an etching solution with a volume ratio of hydrofluoric acid : nitric acid : acetic acid : water of 1 : 13-17 : 4-8 : 4-8 and/or including iodine or iodide in a range from 0.01 g to 0.09 g per 1 liter of total liquid volume of the etching solution. Also, neither Tiemann nor Seki provide any reason or rationale for one of ordinary skill in the art to have modified the etching solutions disclosed therein to be within the claimed ranges at least because neither Tiemann nor Seki describe adjusting an etching solution to be able to evaluate crystal defects of a

silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity, which is the objective of the claimed method.

For at least the reasons stated above, claim 5 would not have been rendered obvious by Tiemann and Seki, individually or in combination. Claim 9 depends from claim 5 and, thus, also would not have been rendered obvious by Tiemann and Seki, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

C. Gantley in View of Seki

The Office Action rejects claims 5 and 9 under 35 U.S.C. §103(a) over U.S. Patent No. 3,960,623 to Gantley ("Gantley") in view of Seki. Applicant respectfully traverses the rejection.

Gantley merely discloses a method for selectively masking portions of a semiconductor body for etching operations. In addition, Gantley discloses that the silicon to be etched is doped to be of the "P" type, and that dimetch (hydrofluoric acid, nitric acid, acetic acid and iodine) works effectively for the etching. See Gantley, col. 3, lines 49-65. However, Gantley fails to teach or suggest the claimed volume ratio of hydrofluoric acid : nitric acid : acetic acid : water of 1 : 13-17 : 4-8 : 4-8, that iodine or iodide should be included in a range from 0.01 g to 0.09 g per 1 liter of total liquid volume of the etching solution, or that the etching rate should be 100 nm/min or less. Further, unlike claim 5, Gantley does not teach or suggest adjusting an etching solution in order to evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity. Therefore, Gantley fails to teach or suggest each and every feature of claim 5. Thus, the Office Action combines the disclosure of Seki with the disclosure of Gantley to address the discrepancies of Gantley as to claim 5.

The disclosure of Seki is discussed above, and for all the reasons discussed above, Seki fails to teach or suggest each and every feature of claim 5. Particularly, Seki discloses that acetic acid acts to damage the photoresist and thus, according to Seki acetic acid should not be used in the etching solution, whereas acetic acid is a significant component in the claimed etching solution. Additionally, Seki discloses that iodine is added to increase an etching rate, whereas according to claim 5, iodine is added to decrease an etching rate. Also, as discussed above, Seki does not teach or suggest modifying the etching solution disclosed therein in order to evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity. Therefore, Seki fails to teach or suggest each and every feature of claim 5.

Further, Gantley is directed to a method for selectively masking portions of a semiconductor body for an etching operation, while Seki is directed to a method for etching silicon semiconductor material using an etching solution. However, neither Gantley nor Seki provide a reason or rationale for one of ordinary skill in the art to have combined these differing methods as suggested by the Office Action. Particularly, as discussed above, Seki discloses that acetic acid should not be used in the etching solution disclosed therein, and Gantley discloses that acetic acid should be used in the etching solution disclosed therein. Therefore, it would not have been obvious to one of ordinary skill in the art to have combined the etching solutions disclosed in the Gantley and Seki references.

Furthermore, even if Gantley and Seki were to have been combined, the combination would not have yielded the method of claim 5 at least because neither Gantley nor Seki disclose an etching solution with a volume ratio of hydrofluoric acid : nitric acid : acetic acid : water of 1 : 13-17 : 4-8 : 4-8 and/or including iodine or iodide in a range from 0.01 g to 0.09 g per 1 liter total liquid volume of the etching solution. Additionally, neither Gantley nor Seki provide a reason or rationale for one of ordinary skill in the art to have modified the

etching solutions disclosed therein to be within the claimed range at least because neither Gantley nor Seki teach or suggest that the etching solution can or should be adjusted in order to evaluate crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity, which is the objective of the claimed method. Therefore, one of ordinary skill in the art would not have modified the etching solutions disclosed in Gantley and Seki to achieve an etching solution capable of evaluating crystal defects of a silicon wafer by observing etch pits formed on the etched surface of the wafer with low electrical resistivity. Thus, Gantley and Seki, individually or in combination, fail to teach or suggest each and every feature of claim 5.

For at least the reasons stated above, claim 5 would not have been rendered obvious by Gantley and Seki, individually or in combination. Claim 9 depends from claim 5 and, thus, also would not have been rendered obvious by Gantley and Seki, individually or in combination. Accordingly, reconsideration and withdrawal of the rejection are respectfully requested.

II. Conclusion

In view of the foregoing, it is respectfully submitted that this application is in condition for allowance. Favorable reconsideration and prompt allowance of the application are earnestly solicited.

Should the Examiner believe that anything further would be desirable in order to place this application in even better condition for allowance, the Examiner is invited to contact the undersigned at the telephone number set forth below.

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